MRF24WN0MA/MB

2.4 GHz IEEE 802.11b/g/n Wireless Module

Features

- IEEE 802.11b/g/n Compliant Transceiver
- 2.4 GHz IEEE 802.11n Single Stream 1x1
- SPI Interface to Host Controller (4-wire including interrupt)
- Works with Microchip's MPLAB® Harmony Integrated Software Framework
- Fully Integrated Wireless Module with Voltage Regulation, Crystal, RF Matching Circuitry, Power Amplifier (PA), Low Noise Amplifier (LNA), and PCB Trace Antenna
- Ultra-Small W.FL Connector for External Antennas (MRF24WN0MB)
- Compact Surface Mount Module: 0.700" x 1.050" x 0.085“ (17.8 mm x 26.7 mm x 2.2 mm)
- Castellated Surface Mount Pads for easy and reliable PCB mounting
- Environmentally Friendly, RoHS Compliant

Operational

- Single Operating Voltage: 3.15V to 3.45V (3.3V typical)
- Temperature Range: -40°C to +85°C Industrial
- Low-Current Consumption:
  - RX mode: 64 mA (typical)
  - TX mode: 246 mA at 18 dBm (typical)
- Power Saving Mode:
  - Hibernate: 10 µA (typical)

RF/Analog

- Frequency: 2.412 to 2.472 GHz
- Channels: 1-13
- Modulation: DSSS, CCK, BPSK, QPSK, 16QAM, 64QAM
- Sensitivity: -94 dBm

Antenna

- Integral PCB Trace Antenna (MRF24WN0MA)
- External Antenna (MRF24WN0MB)

Compliance

- Modular Certified for the United States (FCC) and Canada (IC)
- European R&TTE Directive Assessed Radio Module
- Australia, New Zealand, Korea, Taiwan, and Japan

Applications

- Utility and Smart Energy
- Consumer Electronics
- Industrial Controls
- Remote Device Management
- Retail
- Medical, Fitness, and Health Care

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1.0 DEVICE OVERVIEW

The MRF24WN0MA and MRF24WN0MB are low-power, 2.4 GHz, IEEE 802.11n compliant, surface mount modules containing all associated RF components: crystal oscillator, bypass and bias passives with integrated MAC, baseband, RF and power amplifier, and built-in hardware support for encryption. Refer to Figure 1-1.

The integrated module design frees the designer from RF and antenna design tasks and regulatory compliance testing, ultimately providing faster time to market.

The MRF24WN0MA/MB modules are designed to be used with Microchip's MPLAB® Harmony Integrated Software Framework. The integrated framework implements the Application Programming Interface (API) that is used for command and control, management and data packet traffic.

The MPLAB Harmony basic framework is available via a free download from the Microchip web site at http://www.microchip.com/harmony. For more information on the basic framework and available release versions, refer to *"MPLAB® Harmony Release Notes and Contents"* found under the Documentation tab.

The MRF24WN0MA module is approved for use with the integrated PCB trace antenna. The MRF24WN0MB module is approved for use with specific external antenna types that are certified with the module. An ultra-small coaxial connector (W.FL) is provided on the module for connection to the external antenna. Refer to **Section 3.3, "External Antenna Types"** for a listing of approved antenna types.

The MRF24WN0MA/MB modules received the regulatory approvals for modular devices in the United States (FCC) and Canada (IC). Modular approval removes the need for expensive RF and antenna design, and enables the end user to place the MRF24WN0MA/MB modules inside a finished product without requiring a regulatory testing for an intentional radiator (RF transmitter).

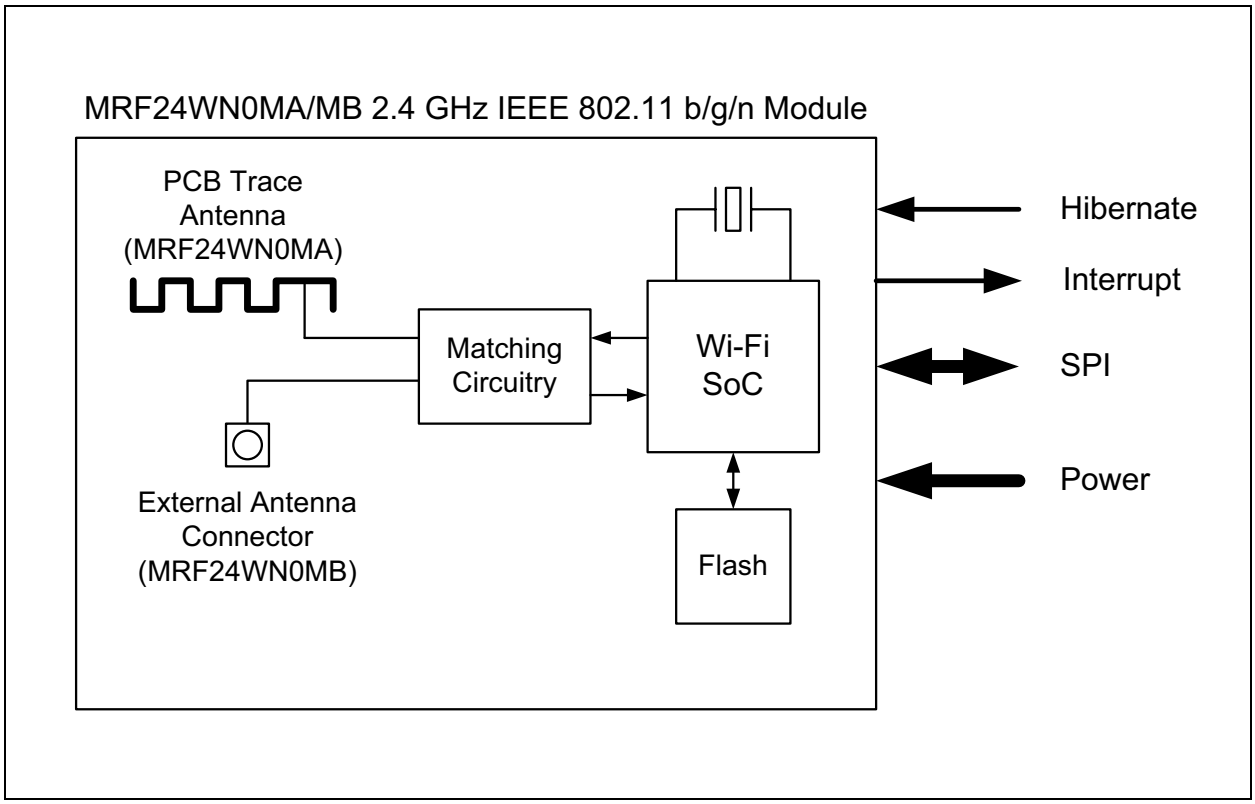
The MRF24WN0MA/MB module is an R&TTE Directive assessed radio module for operation in Europe. The module tests can be applied toward final product certification and Declaration of Conformity (DoC).

Table 1-1 lists the MFR24WN0 module's family types.

TABLE 1-1: MRF24WN0 FAMILY TYPES

Device	Antenna
MRF24WN0MA	Integral
MRF24WN0MB	External

FIGURE 1-1: MRF24WN0MA/MB BLOCK DIAGRAM



1.1 Interface Description

Figure 1-2 shows the MRF24WN0MA/MB pin diagram. Table 1-2 describes the MRF24WN0MA/MB pins.

FIGURE 1-2: MRF24WN0MA/MB PIN DIAGRAM

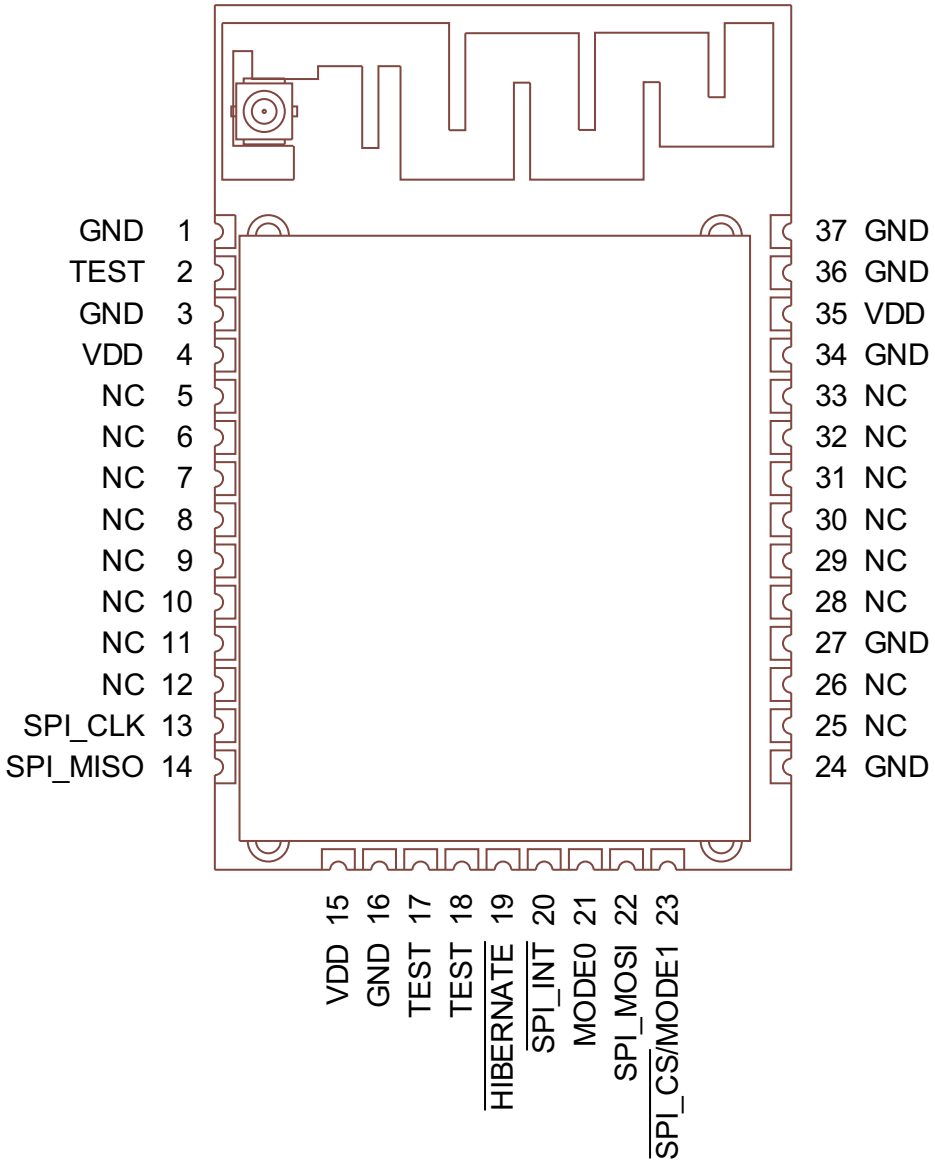


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TABLE 1-2: PIN DESCRIPTIONS

Pin	Name	Type	Description[1]
1	GND	Power	—
2	TEST	Test	Do not connect
3	GND	Power	—
4	VDD	Power	—
5	NC	Reserved	Do not connect
6	NC	Reserved	Do not connect
7	NC	Reserved	Do not connect
8	NC	Reserved	Do not connect
9	NC	Reserved	Do not connect
10	NC	Reserved	Do not connect
11	NC	Reserved	Do not connect
12	NC	Reserved	Do not connect
13	SPI_CLK	DI	SPI clock input
14	SPI_MISO	DO	SPI data output; pull-down to GND with 10 kilo-ohm resistor
15	VDD	Power	—
16	GND	Power	—
17	TEST	Test	Do not connect
18	TEST	Test	Do not connect
19	$\overline{\text{HIBERNATE}}$	DI	Lowest Power State (active-low)
20	SPI_INT	DO	SPI interrupt output (active-low)
21	MODE0	DI	Mode select 0; Connect to GND[2]
22	SPI_MOSI	DI	SPI data input
23	$\overline{\text{SPI_CS}}$/MODE1	DI	SPI Chip Select/Mode select 1; Connect to VDD via 10 kilo-ohm pull-up resistor[2][3]
24	GND	Power	—
25	NC	Reserved	Do not connect
26	NC	Reserved	Do not connect
27	GND	Power	—
28	NC	Reserved	Do not connect
29	NC	Reserved	Do not connect
30	NC	Reserved	Do not connect
31	NC	Reserved	Do not connect
32	NC	Reserved	Do not connect
33	NC	Reserved	Do not connect
34	GND	Power	—
35	VDD	Power	—
36	GND	Power	—
37	GND	Power	—

Legend: A = Analog, D = Digital, I = Input, O = Output

Note 1: For NC = No Connect pins, do not make any connection. The module is configured with internal pull-up and pull-down resistors.

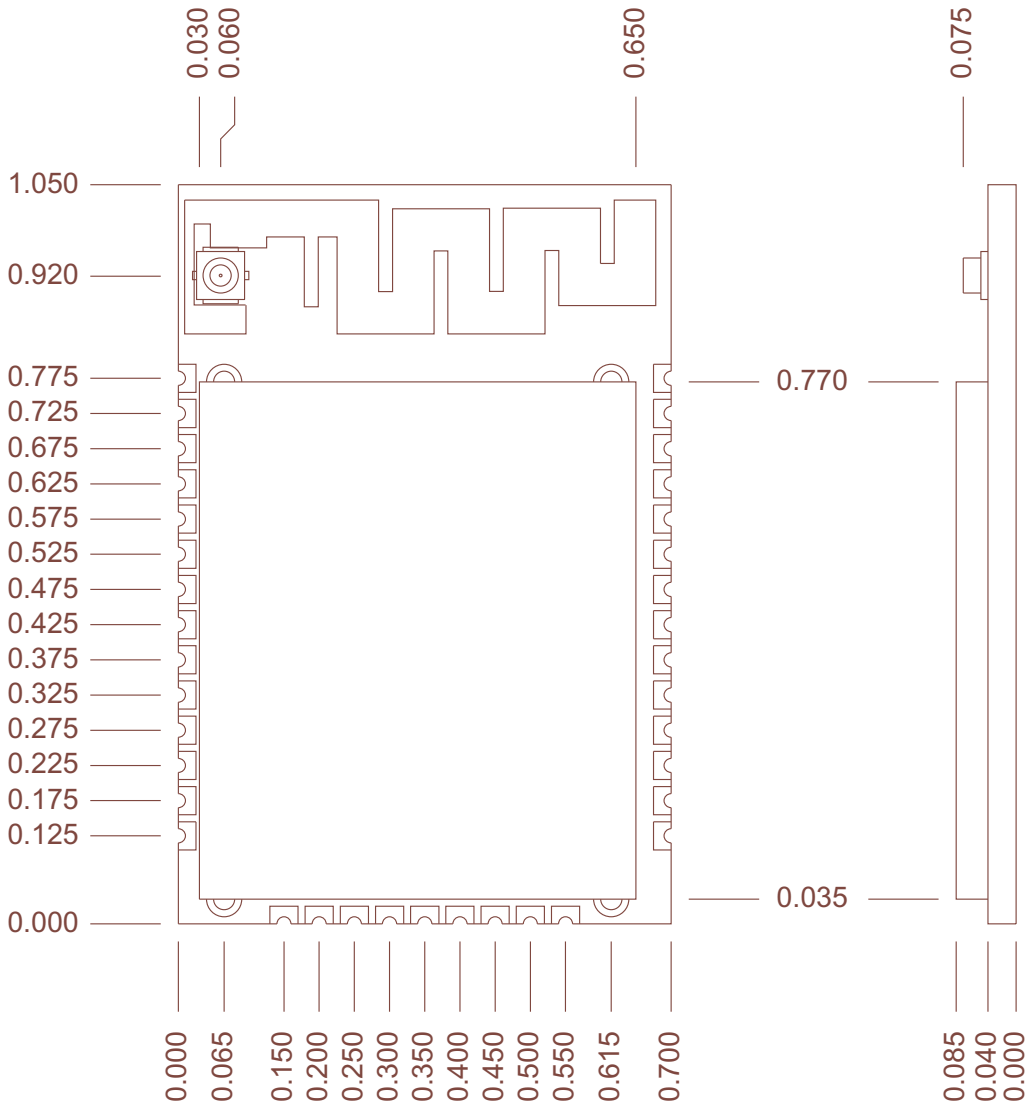
2: Refer to **Section 2.2, "MODE0 and MODE1 Pins"**

3: Refer to **Section 2.3, "SPI Port Pins"**

1.2 Mounting Details

Figure 1-3, Figure 1-4 and Figure 1-5 show the physical dimensions and the mounting details of the module. Figure 1-6 and Figure 1-7 show the recommended host PCB footprint and layout.

FIGURE 1-3: MRF24WN0MA/MB MODULE PHYSICAL DIMENSIONS (TOP AND SIDE VIEW)



Dimensions are in inches.

Tolerances:

PCB outline: +/- 0.010"

PCB thickness: +/- 0.005"

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FIGURE 1-4: MRF24WN0MA/MB MODULE PHYSICAL DIMENSIONS (BOTTOM VIEW)

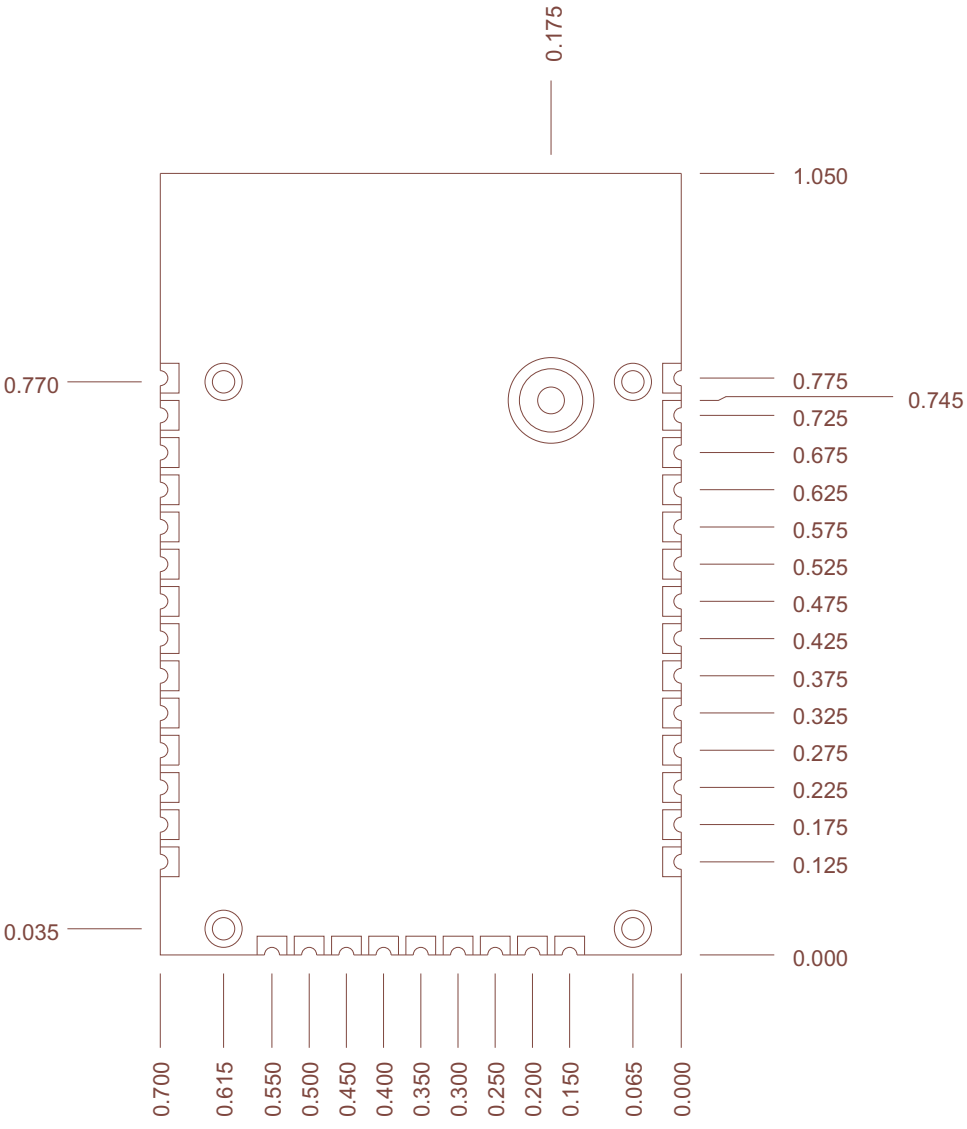

FIGURE 1-5: MRF24WN0MA/MB MODULE MOUNTING DETAILS

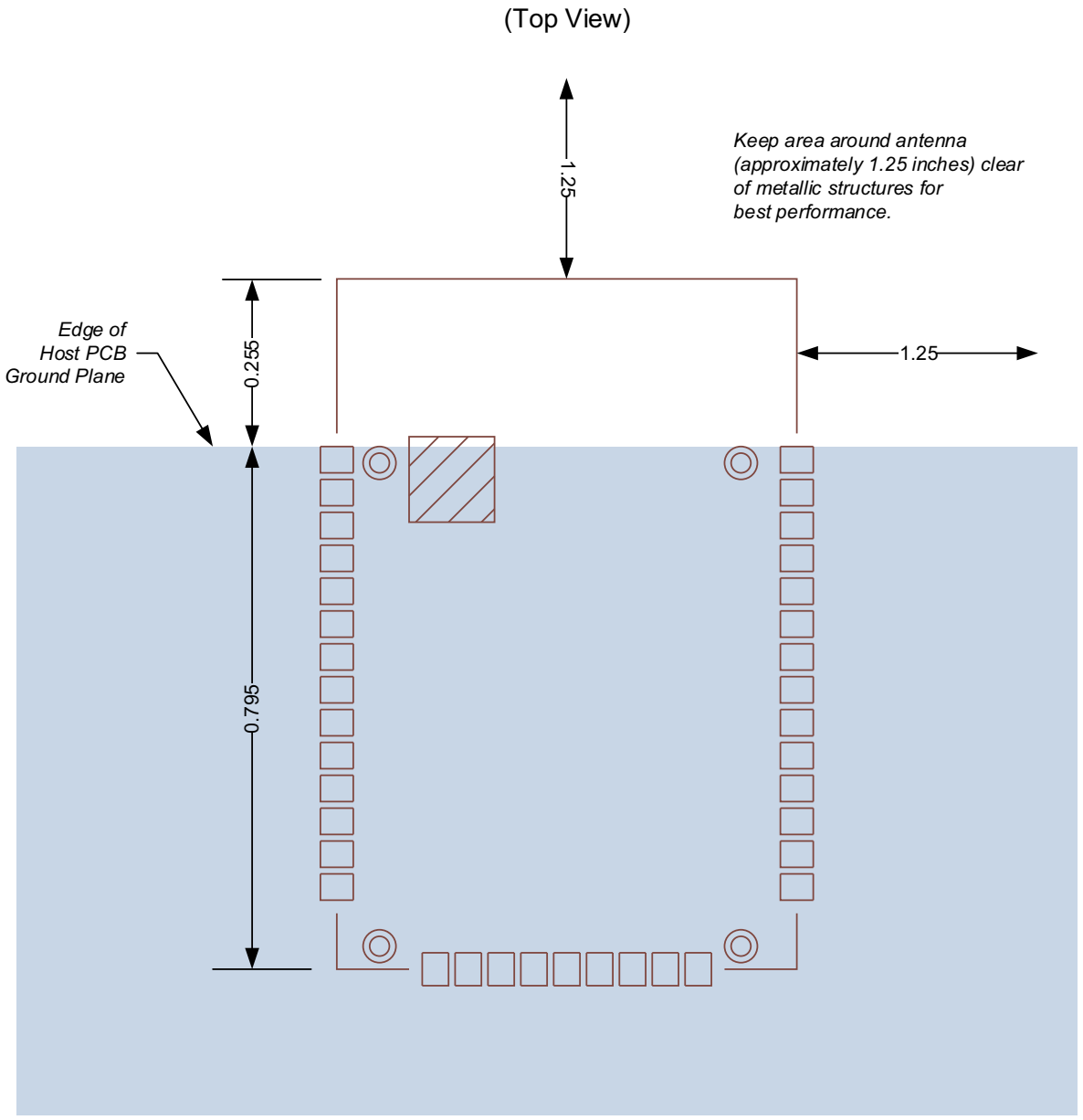

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FIGURE 1-6: MRF24WN0MA/MB RECOMMENDED HOST PCB FOOTPRINT

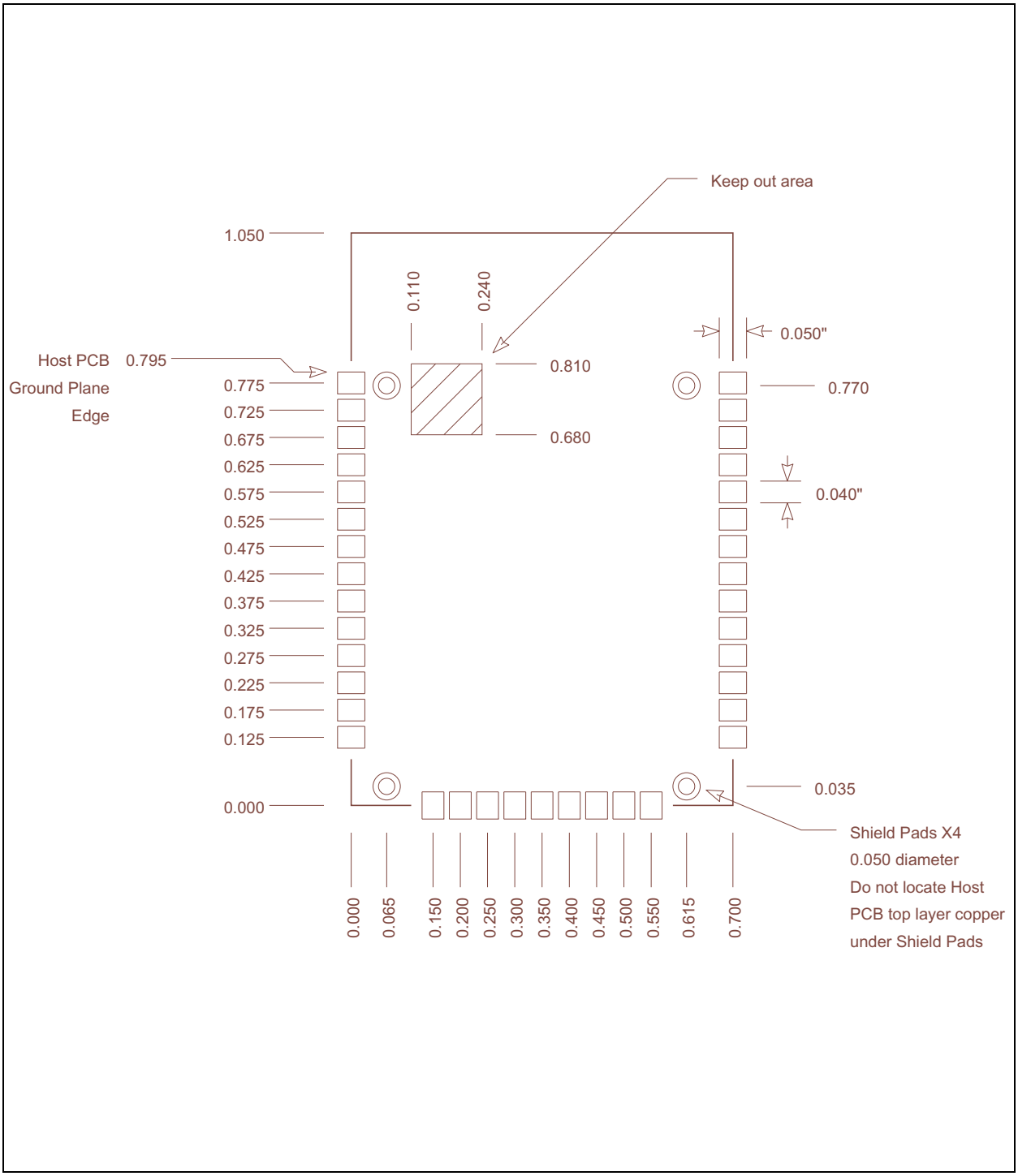
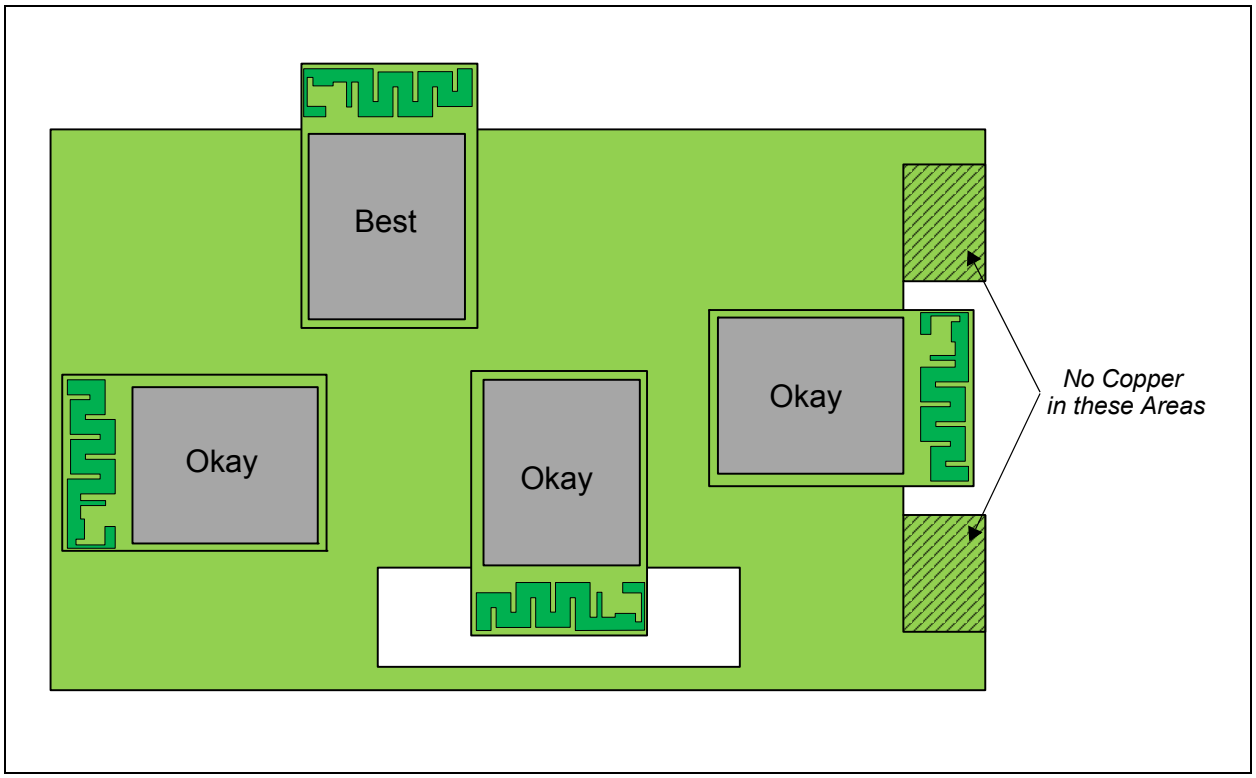


FIGURE 1-7: MRF24WN0MA/MB HOST PCB EXAMPLE LAYOUT



1.3 Soldering Recommendations

The MRF24WN0MA/MB wireless module was assembled using the IPC/JEDEC J-STD-020 Standard lead-free reflow profile. The MRF24WN0MA/MB module can be soldered to the host PCB using standard leaded and lead-free solder reflow profiles.

To avoid damaging the module, adhere to the following recommendations:

- Solder reflow recommendations are provided in the Microchip Application Note, *AN233 "Solder Reflow Recommendation"* (DS00233)
- Do not exceed a peak temperature (T_P) of 250°C
- Refer to the solder paste data sheet for specific reflow profile recommendations from the vendor
- Use no-clean flux solder paste
- Do not wash as moisture can be trapped under the shield
- Use only one flow. If the PCB requires multiple flows, apply the module on the final flow.

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2.0 CIRCUIT DESCRIPTION

2.1 Overview

The MRF24WN0MA/MB module interfaces to the PIC32 MCU via a 4-wire SPI port, Interrupt and Hibernate pins as illustrated in Figure 2-1. The MRF24WN0MA/MB modules are designed to work with Microchip's MPLAB® Harmony Integrated Software Framework. The integrated framework implements the Application Programming Interface (API) that is used for command and control, management and data packet traffic.

The MPLAB Harmony basic framework is available via a free download from the Microchip web site at http://www.microchip.com/harmony. For more information on the basic framework and available release versions, refer to the *"MPLAB Harmony Release Notes and Contents"* found under the Documentation tab.

If you are new to the MPLAB Harmony framework, visit http://www.microchip.com/harmony and go to the *Training > Getting Started* tab.

The MPLAB Harmony Help document is available for download from the MPLAB Harmony framework directory: `c:\microchip\harmony\<version>\doc`.

The PIC32 input/output ports (SPI, Interrupt and Hibernate) are configured in the MPLAB Harmony framework configuration files as described in the MPLAB Harmony Help document.

2.2 MODE0 and MODE1 Pins

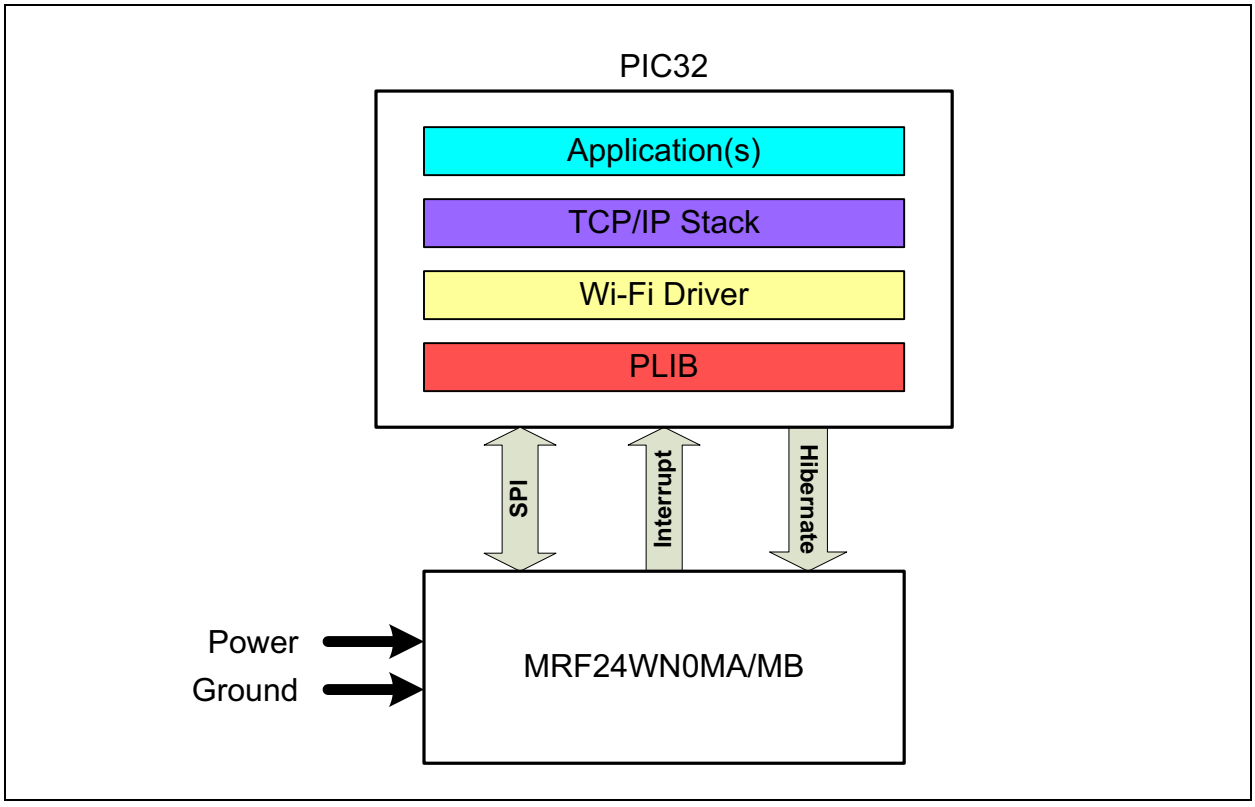
The MODE pins must be tied to the voltage levels for normal operation of the module. Refer to Table 2-1.

TABLE 2-1: MODE PIN OPERATION

Pin	Condition
MODE0	Connect to GND
$\overline{\text{SPI_CS}}$/MODE1	Connect to VDD via 10 kΩ pull-up resistor

The MODE pins are sampled at power on and wake-up. Refer to **Section 2.6, "Hibernate"**. In the case of $\overline{\text{SPI_CS}}$/MODE1 pin, pull-up using a 10 kΩ resistor and the host MCU allows an active-high signal during power on and wake-up to ensure that the module start-up in normal operation. Once the module is operational, the pin becomes the SPI Port Chip Select pin (active-low).

FIGURE 2-1: HARMONY TO MRF24WN0MA/MB BLOCK DIAGRAM



2.3 SPI Port Pins

The MRF24WN0MA/MB module interfaces to the PIC32 MCU via a 4-wire SPI port. Refer to Figure 2-2 and Table 2-2 for the necessary signaling conditions.

In the case of the $\overline{\text{SPI_CS}}$/MODE1 pin, pull-up using a 10 kΩ resistor and the host MCU allows an active-high signal during power on and wake-up to ensure that the module start-up in normal operation. Once the module is operational, the pin becomes the SPI Port Chip Select pin (active-low).

FIGURE 2-2: SPI SLAVE INTERFACE TIMING

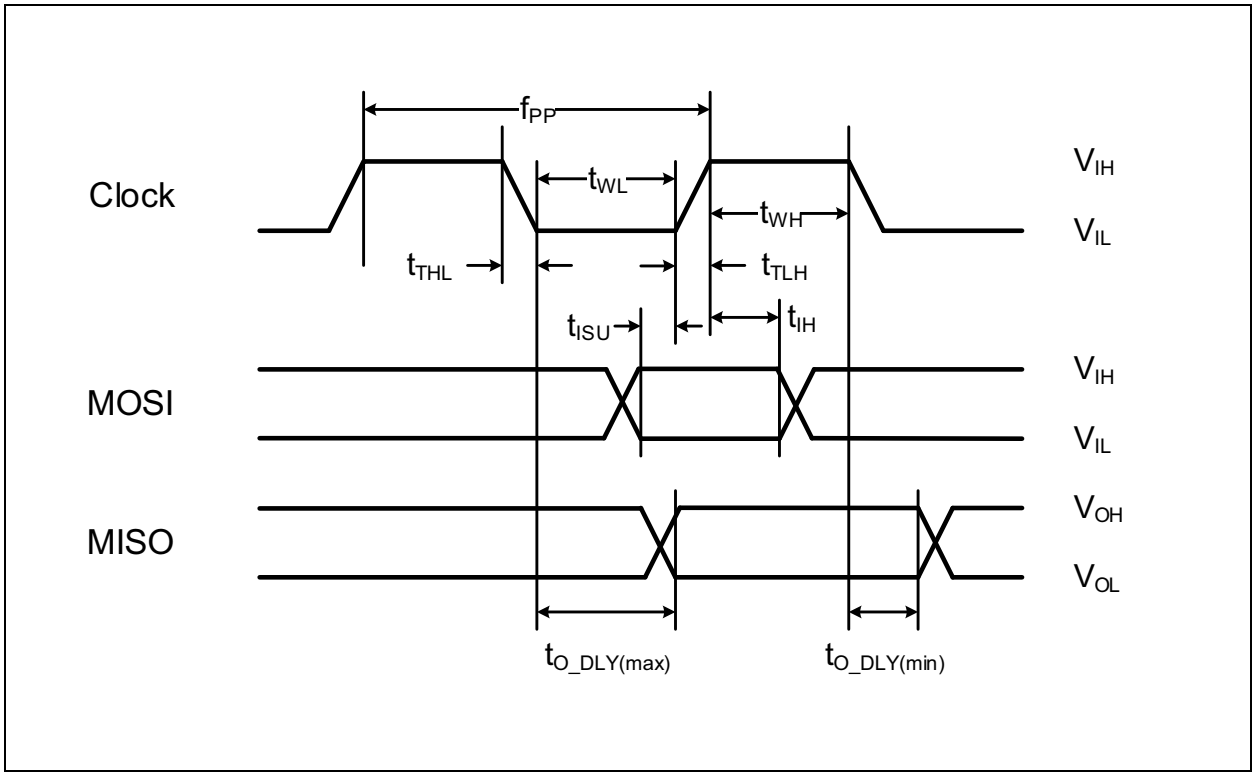


TABLE 2-2: SPI SLAVE TIMING CONSTRAINTS

Parameter	Description	Min.	Max.	Unit
f_{PP}	Clock Frequency	0	48	MHz
t_{WL}	Clock Low Time	8.3	—	ns
t_{WH}	Clock High Time	8.3	—	ns
t_{TLH}	Clock Rise Time	—	2	ns
t_{THL}	Clock Fall Time	—	2	ns
t_{ISU}	Input Setup Time	5	—	ns
t_{IH}	Input Hold Time	5	—	ns
t_{O_DLY}	Output Delay	0	5	ns

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2.4 Interrupt Pin

The $\overline{\text{SPI_INT}}$ line works in conjunction with the SPI port. It is an active-low output signal to the host MCU to signal an interrupt event.

2.5 VDD and GND Pin

The MRF24WN0MA/MB wireless module contains an integrated power management unit that generates all necessary voltages required by the internal circuitry. The module is powered from a single voltage source.

Table 2-3 lists the recommended bypass capacitors. The capacitors must be closely placed to the module.

TABLE 2-3: RECOMMENDED BYPASS CAPACITORS

Pin	Symbol	Bypass Capacitors
4	VDD	0.1 µF and 2.2 µF
15	VDD	0.1 µF and 2.2 µF
35	VDD	0.1 µF and 2.2 µF

2.6 Hibernate

The module enters the lowest power mode when the $\overline{\text{HIBERNATE}}$ pin is asserted low. No state information is preserved. The MPLAB Harmony framework can save state information in the host MCU that can be restored after wake-up ($\overline{\text{HIBERNATE}}$ pin is asserted high).

The module can wake-up when $\overline{\text{HIBERNATE}}$ pin is asserted high. The module must be initialized and any state information saved prior to Hibernate state is restored. This process approximately takes 40 ms.

NOTES:

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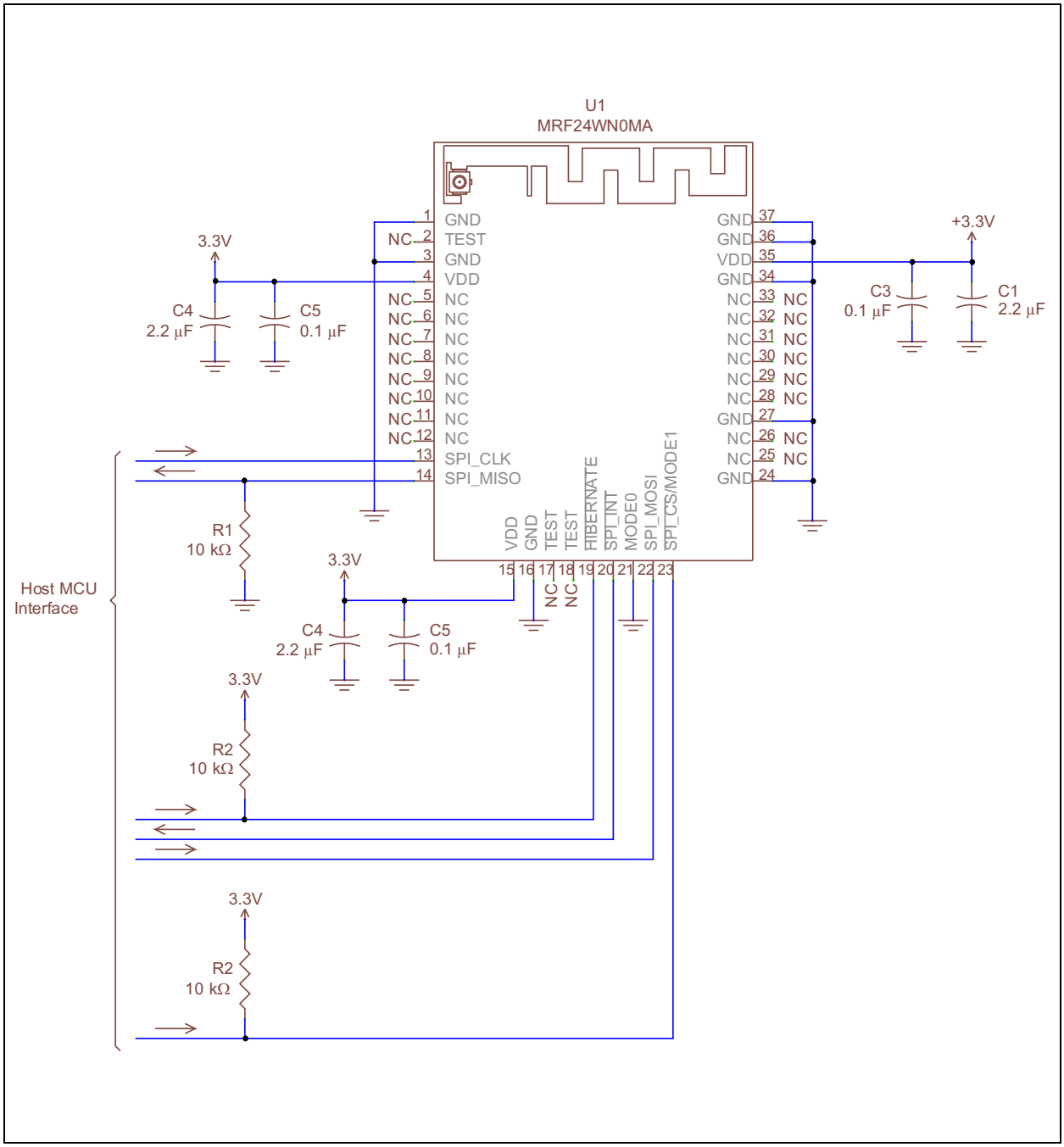
3.0 APPLICATION INFORMATION

This section provides information on the Application Schematic, Integral PCB Trace Antenna, and Antenna Types.

3.1 Application Schematic

Figure 3-1 shows the schematic for the MRF24WN0MA module.

FIGURE 3-1: APPLICATION SCHEMATIC



3.2 Integral PCB Trace Antenna

For the MRF24WN0MA, the PCB antenna is fabricated on the top copper layer and covered in solder mask. The layers below the antenna do not have copper trace.

It is recommended that the module is mounted on the edge of the host PCB. It is permitted for PCB material to be below the antenna structure of the module as long as no copper traces or planes are on the host PCB in that area. For best performance, place the module on the host PCB according to the details shown in Figure 1-6.

The antenna patterns plotted in Figure 3-2 through Figure 3-5 are the simulated results of the PCB antenna.

Figure 3-2 illustrates the simulation drawing. The two-dimensional (2D) radiation pattern is illustrated in Figure 3-3, whereas Figure 3-4 and Figure 3-5 shows the three-dimensional (3D) radiation patterns.

The calculated average of the radiated field is shown in Figure 3-3. The radiation pattern for the XZ plane is shown in red, whereas the YZ plane is shown in violet. The most powerful radiation occurs in the XZ plane as represented by the red pattern.

Figure 3-4 shows the relative position of the 3D radiation “donut” with reference to the module orientation. This is a very useful guide for placement of the module to obtain the maximum range.

Figure 3-5 shows the 3D radiation pattern with the colored distribution of the radiation magnitude. The values range from -9 dB to +0.3 dB. This is very useful in interpreting the 2D radiation pattern.

FIGURE 3-2: PCB ANTENNA SIMULATION DRAWING

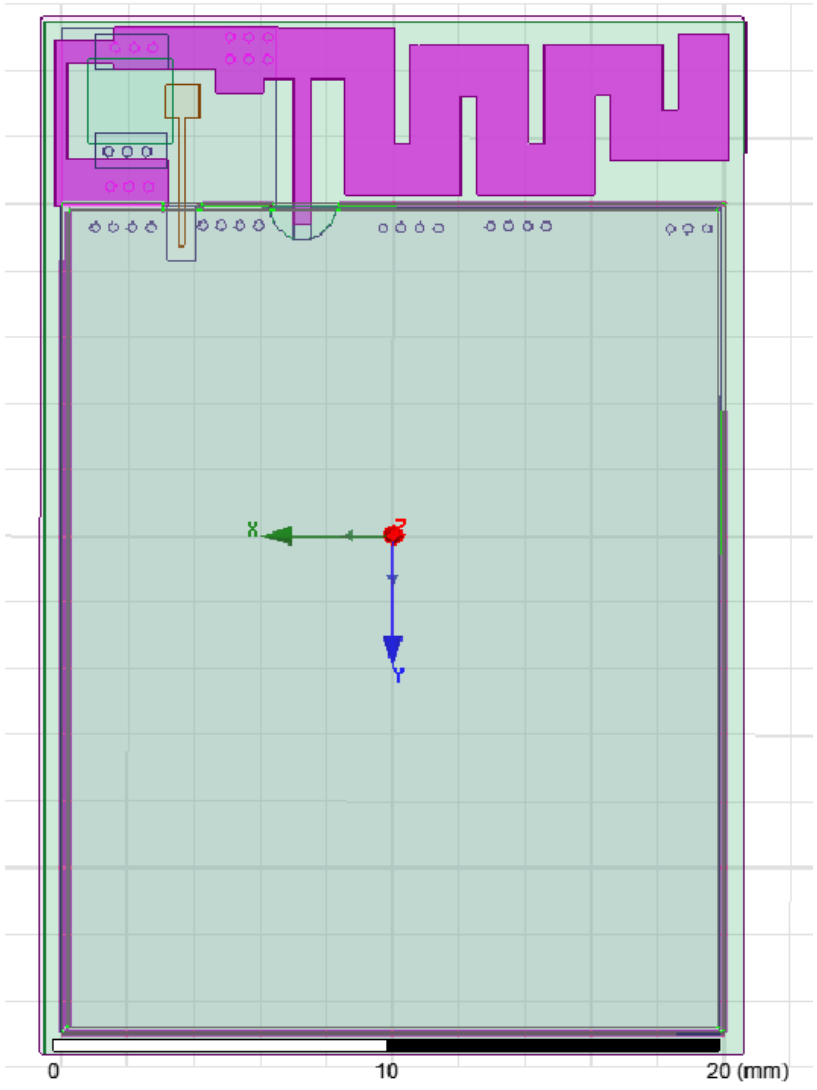


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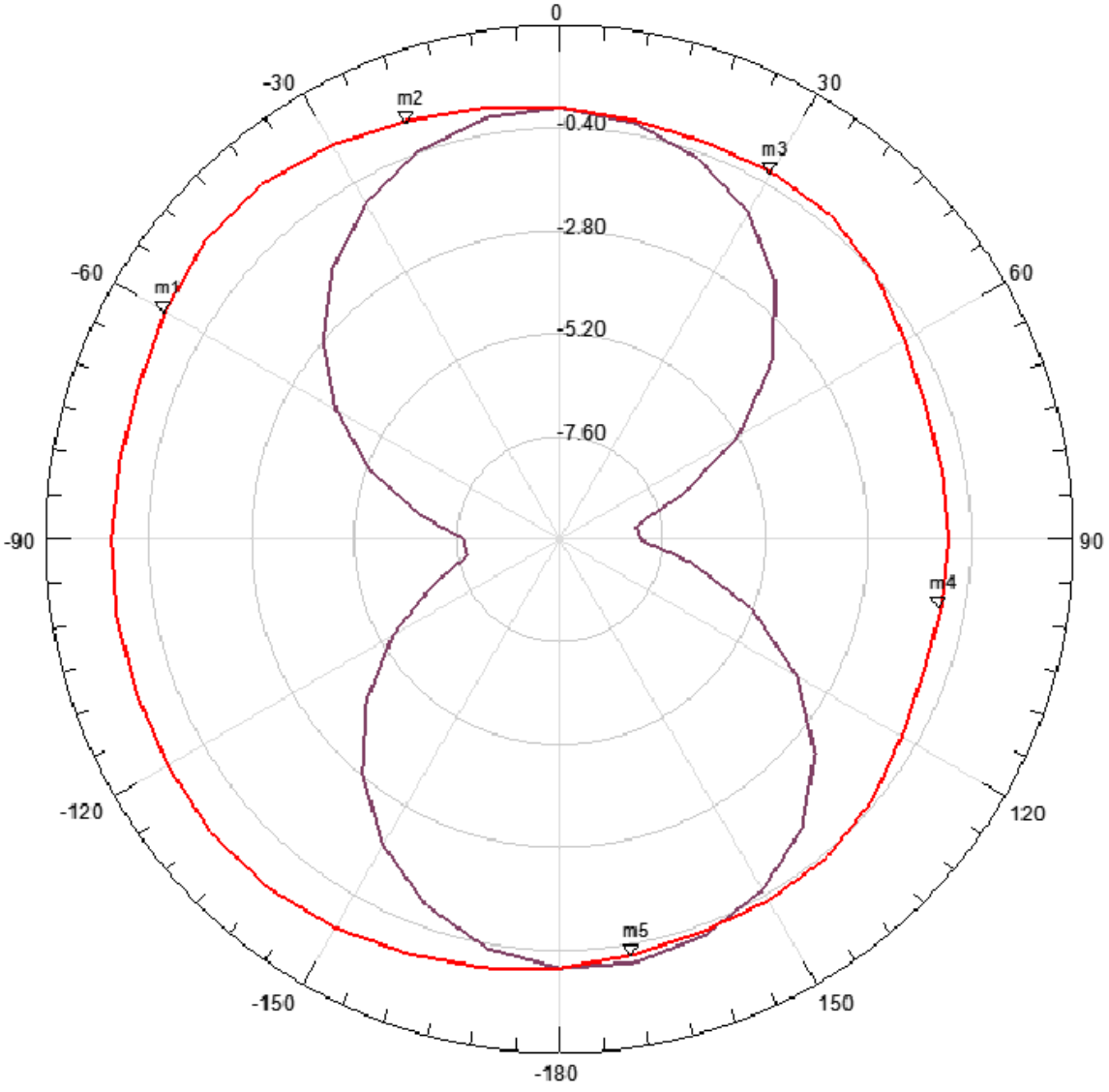
FIGURE 3-3: SIMULATED TWO-DIMENSIONAL RADIATION PATTERN

Name	Theta	Angle	Mag.
m1	-60.0000	-60.0000	0.6323
m2	-20.0000	-20.0000	0.3962
m3	30.0000	30.0000	-0.1038
m4	100.0000	100.0000	-0.9490
m5	170.0000	170.0000	-0.1414

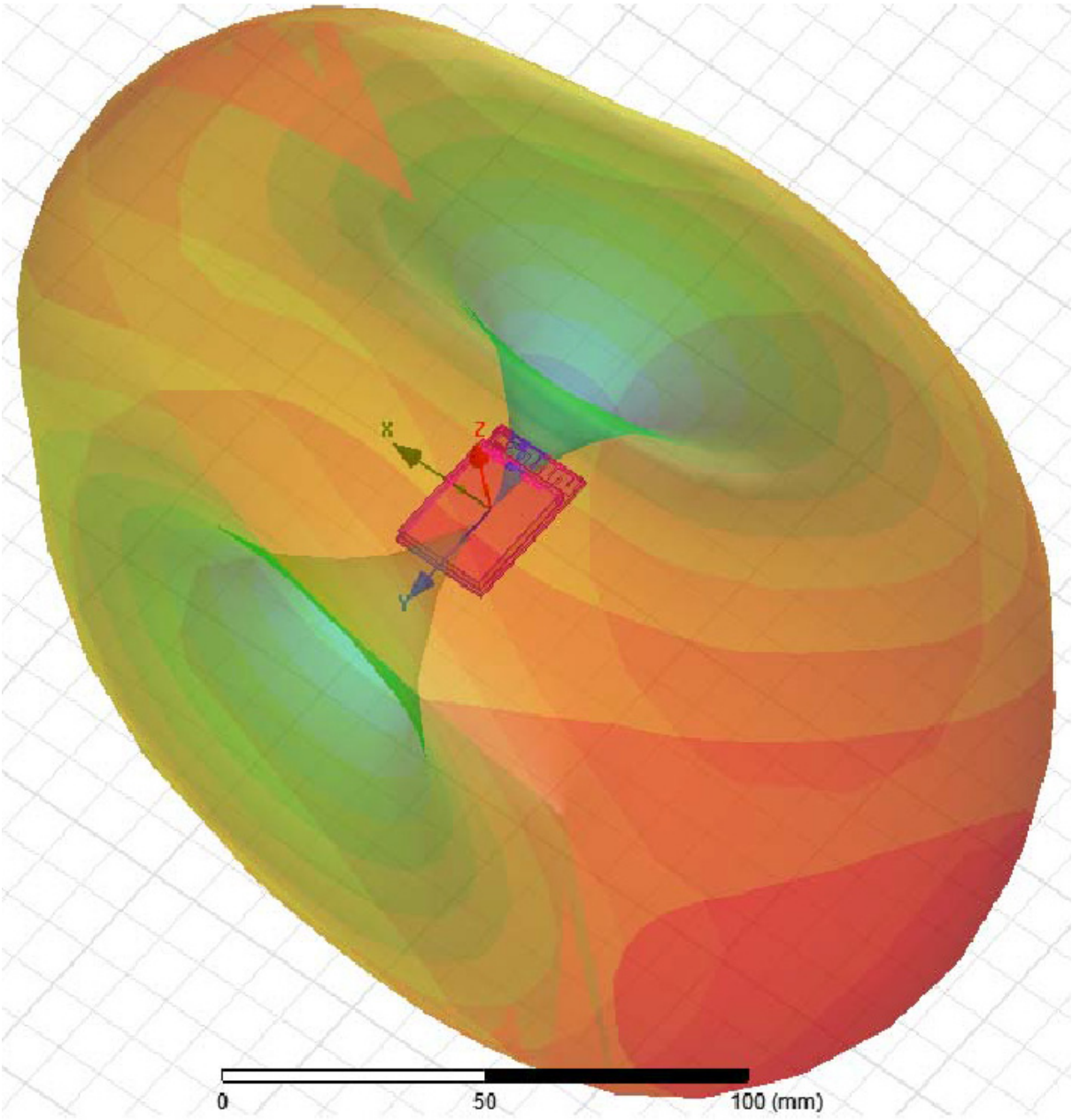
Curve Information	Average
dB (Gain Total) Setup 1: Last Adaptive Freq. = “2.44 GHz” Phi = “0 deg”	0.0097
dB (Gain Total) Setup 2: Last Adaptive Freq. = “2.44 GHz” Phi = “0 deg”	-3.2020

Radiation Pattern 1



Two-dimensional (2D) pattern, including the average on main radiation planes (Phi = 0 and 90 degrees).

FIGURE 3-4: SIMULATED THREE-DIMENSIONAL RADIATION PATTERN



Radiation pattern against the module dimensions

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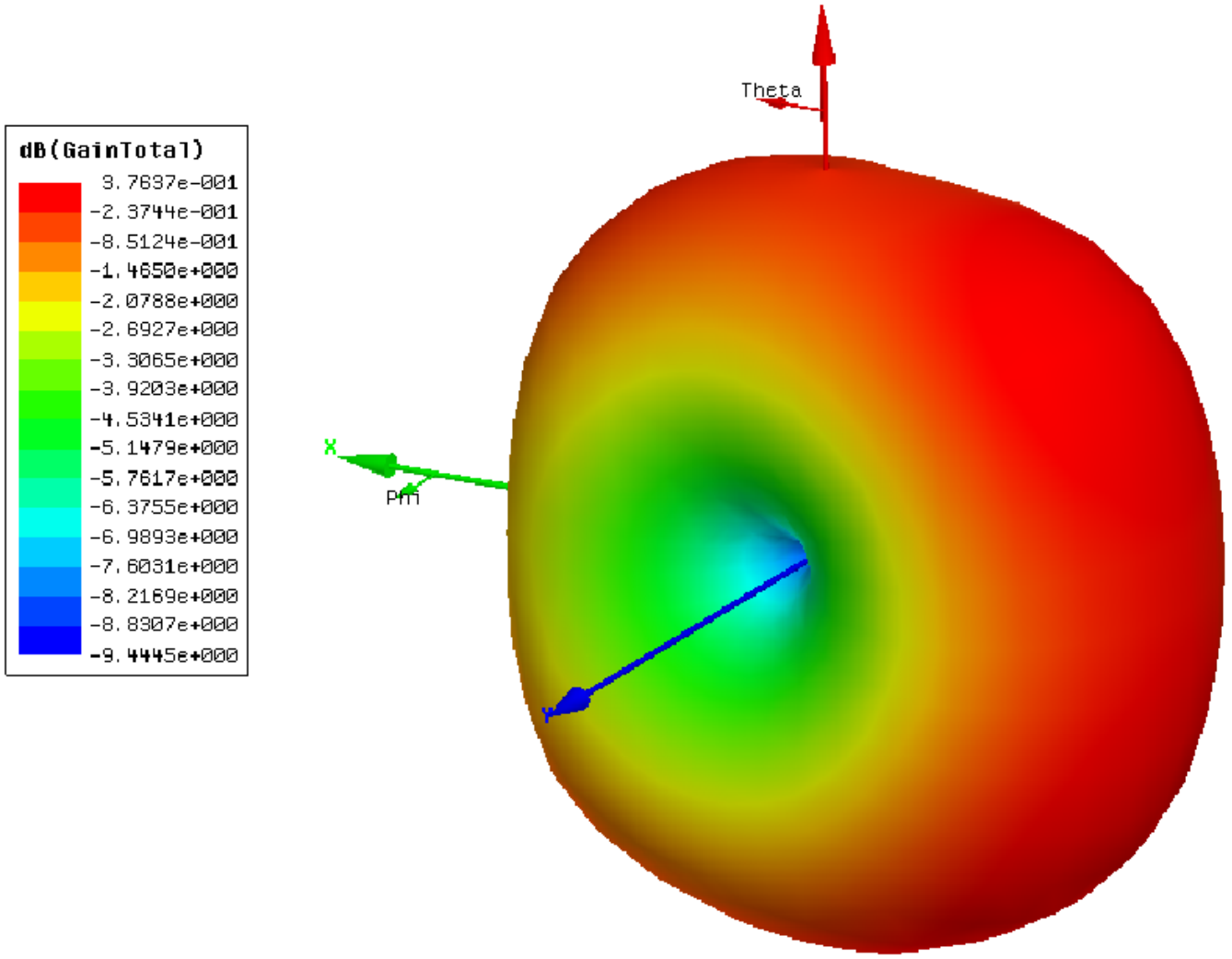
FIGURE 3-5: SIMULATED THREE-DIMENSIONAL RADIATION PATTERN



Three-dimensional (3D) pattern and magnitude distribution

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3.3 External Antenna Types

The MRF24WN0MB module has an ultra-small coaxial connector (W.FL) for connection to the external antenna.

The choice of antenna is limited to the antenna types in which the module is tested and approved. For a list of tested and approved antenna types that may be used with the module, refer to the respective country in **Section 4.0, Regulatory Approval**.

Table 3-1 lists the approved antennas types.

TABLE 3-1: TESTED EXTERNAL ANTENNA TYPES

Type	Gain
PCB Trace	1 dBi
Dipole	2 dBi
PIFA	-3 dBi

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4.0 REGULATORY APPROVAL

This section outlines the regulatory information for the MRF24WN0MA/MB module for the following countries:

- United States
- Canada
- Europe
- Australia
- New Zealand
- Japan
- Korea
- Taiwan
- Other Regulatory Jurisdictions

4.1 United States

The MRF24WN0MA/MB module has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C “Intentional Radiators” modular approval in accordance with Part 15.212 Modular Transmitter approval. Modular approval allows the end user to integrate the MRF24WN0MA/MB module into a finished product without obtaining subsequent and separate FCC approvals for intentional radiation, provided no changes or modifications are made to the module circuitry. Changes or modifications could void the user’s authority to operate the equipment. The end user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance.

The finished product is required to comply with all applicable FCC equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion. For example, compliance must be demonstrated to regulations for other transmitter components within the host product; to requirements for unintentional radiators (Part 15 Subpart B “Unintentional Radiators”), such as digital devices, computer peripherals, radio receivers, etc.; and to additional authorization requirements for the non-transmitter functions on the transmitter module (i.e., Verification, or Declaration of Conformity) (e.g., transmitter modules may also contain digital logic functions) as appropriate.

4.1.1 LABELING AND USER INFORMATION REQUIREMENTS

The MRF24WN0MA/MB module has been labeled with its own FCC ID number, and if the FCC ID is not visible when the module is installed inside another device, then the outside of the finished product into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording as follows:

> MRF24WN0MA/MB**:**
> Contains Transmitter Module FCC ID: W7O24WN0
> *or*
>
> Contains FCC ID: W7O24WN0
>
> This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation

A user’s manual for the product should include the following statement:

> This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
>
> - Reorient or relocate the receiving antenna.
> - Increase the separation between the equipment and receiver.
> - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
> - Consult the dealer or an experienced radio/TV technician for help.

Additional information on labeling and user information requirements for Part 15 devices can be found in KDB Publication 784748 available at the FCC Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB) http://apps.fcc.gov/oetcf/kdb/index.cfm.

4.1.2 RF EXPOSURE

All transmitters regulated by FCC must comply with RF exposure requirements. KDB 447498 General RF Exposure Guidance provides guidance in determining whether proposed or existing transmitting facilities, operations or devices comply with limits for human exposure to Radio Frequency (RF) fields adopted by the Federal Communications Commission (FCC).

This module is approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC multitransmitter guidelines. End users must be provided with transmitter operating conditions for satisfying RF Exposure compliance.

4.1.3 APPROVED EXTERNAL ANTENNA TYPES

To maintain modular approval in the United States, only the antenna types that have been tested shall be used. It is permissible to use different antenna manufacturers provided the same antenna type that has similar inband and out-of-band radiation patterns and antenna gain (equal to or less than) is used.

Modular approval testing of the MRF24WN0MA/MB module was performed with the antenna types listed in Table 3-1.

4.1.4 HELPFUL WEB SITES

Federal Communications Commission (FCC):
http://www.fcc.gov

FCC Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB):
http://apps.fcc.gov/oetcf/kdb/index.cfm

4.2 Canada

The MRF24WN0MA/MB module has been certified for use in Canada under Industry Canada (IC) Radio Standards Specification (RSS) RSS-210 and RSSGen. Modular approval permits the installation of a module in a host device without the need to recertify the device.

4.2.1 LABELING AND USER INFORMATION REQUIREMENTS

Labeling Requirements for the Host Device (from Section 3.2.1, RSS-Gen, Issue 3, December 2010): The host device shall be properly labeled to identify the module within the host device.

The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the Industry Canada certification number of the module, preceded by the words “Contains transmitter module”, or the word “Contains”, or similar wording expressing the same meaning, as follows:

Contains transmitter module IC: 7693A-24WN0

User Manual Notice for License-Exempt Radio Apparatus (from Section 7.1.3 RSS-Gen, Issue 3, December 2010): User manuals for license-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device. Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Transmitter Antenna (from Section 7.1.2 RSS-Gen, Issue 3, December 2010): User manuals for transmitters shall display the following notice in a conspicuous location:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

The above notice may be affixed to the device instead of displayed in the user manual.

4.2.2 RF EXPOSURE

All transmitters regulated by IC must comply with RF exposure requirements listed in RSS-102 - Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands).

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This module is approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with Industry Canada's multi-transmitter guidelines. End users must be provided with transmitter operating conditions for satisfying RF Exposure compliance.

4.2.3 APPROVED EXTERNAL ANTENNA TYPES

Transmitter Antenna (from Section 7.1.2 RSS-Gen, Issue 3, December 2010):

The MRF24WN0MA/MB module can only be sold or operated with antennas with which it was approved. Transmitter may be approved with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns. Testing shall be performed using the highest gain antenna of each combination of transmitter and antenna type for which approval is being sought, with the transmitter output power set at the maximum level. Any antenna of the same type having equal or lesser gain as an antenna that had been successfully tested with the transmitter, will also be considered approved with the transmitter, and may be used and marketed with the transmitter.

When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on measurement or on data from the antenna manufacturer. For transmitters of output power greater than 10 milliwatts, the total antenna gain shall be added to the measured RF output power to demonstrate compliance to the specified radiated power limits.

Modular approval testing of the MRF24WN0MA/MB module was performed with the antenna types listed in Table 3-1.

4.2.4 HELPFUL WEB SITES

Industry Canada: http://www.ic.gc.ca/

4.3 Europe

The MRF24WN0MA/MB module is an R&TTE Directive assessed radio module that is CE marked and has been manufactured and tested with the intention of being integrated into a final product.

The MRF24WN0MA/MB module has been tested to R&TTE Directive 1999/5/EC Essential Requirements for Health and Safety (Article (3.1(a)), Electromagnetic Compatibility (EMC) (Article 3.1(b)), and Radio (Article 3.2) and are summarized in Table 3-1: European Compliance Testing. A Notified Body Opinion has also been issued. All test reports are available on the MRF24WN0MA/MB product web page at http://www.microchip.com.

The R&TTE Compliance Association provides guidance on modular devices in document **Technical Guidance Note 01** available at http://www.rtteca.com/html/download_area.htm.

> **Note:** To maintain conformance to the testing listed in Table 4-1, the module shall be installed in accordance with the installation instructions in this data sheet and shall not be modified.
>
> When integrating a radio module into a completed product the integrator becomes the manufacturer of the final product and is therefore responsible for demonstrating compliance of the final product with the essential requirements of the R&TTE Directive.

4.3.1 LABELING AND USER INFORMATION REQUIREMENTS

The label on the final product which contains the MRF24WN0MA/MB module must follow CE marking requirements. The *"R&TTE Compliance Association Technical Guidance Note 01"* provides guidance on final product CE marking.

4.3.2 EXTERNAL ANTENNA REQUIREMENTS

From R&TTE Compliance Association document **Technical Guidance Note 01**:

> Provided the integrator installing an assessed radio module with an integral or specific antenna and installed in conformance with the radio module manufacturer's installation instructions requires no further evaluation under Article 3.2 of the R&TTE Directive and does not require further involvement of an R&TTE Directive Notified Body for the final product. [Section 2.2.4]

The European Compliance Testing listed in Table 4-1 was performed using the antenna types listed in Table 3-1.

4.3.3 HELPFUL WEB SITES

A document that can be used as a starting point in understanding the use of Short Range Devices (SRD) in Europe is the European Radio Communications Committee (ERC) Recommendation 70-03 E, which can be downloaded from the European Radio Communications Office (ERO) at: http://www.ero.dk/.

Additional helpful web sites are:

- Radio and Telecommunications Terminal Equipment (R&TTE): http://ec.europa.eu/enterprise/rtte/index_en.htm
- European Conference of Postal and Telecommunications Administrations (CEPT): http://www.cept.org/

- European Telecommunications Standards Institute (ETSI): http://www.etsi.org
- European Radio Communications Office (ERO): http://www.ero.dk/
- The Radio and Telecommunications Terminal Equipment Compliance Association (R&TTE CA): http://www.rtteca.com/

TABLE 4-1: MRF24WN0MA/MB EUROPEAN COMPLIANCE TESTING

Certification	Standards	Article	Laboratory	Report Number	Date
Safety	EN 60950-1:2006+A11:2009+A1:2010 +A12:2011	[3.1(a)]		Pending	
Health	EN 62479:2010			Pending	
EMC	EN 301 489-1 V1.9.2 (2011-09)	[3.1(b)]		Pending	
	EN 301 489-17 V2.2.1 (2012-09)				
Radio	EN 300 328 V1.8.1 (2006-06)	(3.2)		Pending	
Notified Body Opinion				Pending	

4.4 Australia

The Australia radio regulations do not provide a modular approval policy similar to the United States (FCC) and Canada (IC). However, MRF24WN0MA/MB module RF transmitter test reports can be used in part to demonstrate compliance in accordance with ACMA Radio communications “Short Range Devices” Standard 2004 (The Short Range Devices standard calls up the AS/NZS 4268:2008 industry standard). The MRF24WN0MA/MB module test reports can be used as part of the product certification and compliance folder. For more information on the RF transmitter test reports, contact Microchip Technology Australia sales office.

To meet overall Australian final product compliance, the developer must construct a compliance folder containing all relevant compliance test reports e.g. RF, EMC, electrical safety and DoC (Declaration of Conformity) etc. It is the responsibility of the integrator to know what is required in the compliance folder for ACMA compliance. All test reports are available on the MRF24WN0MA/MB product web page at http://www.microchip.com. For more information on Australia compliance, refer to the Australian Communications and Media Authority web site http://www.acma.gov.au/.

4.4.1 EXTERNAL ANTENNA REQUIREMENTS

The compliance testing listed in Table 4-1 was performed using the antenna types listed in Table 3-1.

4.4.2 HELPFUL WEB SITES

The Australian Communications and Media Authority: www.acma.gov.au/.

4.5 New Zealand

The New Zealand radio regulations do not provide a modular approval policy similar to the United States (FCC) and Canada (IC). However, MRF24WN0MA/MB module RF transmitter test reports can be used in part to demonstrate compliance against the New Zealand “General User Radio License for Short Range Devices”. New Zealand Radio communications (Radio Standards) Notice 2010 calls up the AS / NZS 4268:2008 industry standard. The MRF24WN0MA/MB module test reports can be used as part of the product certification and compliance folder. All test reports are available on the MRF24WN0MA/MB product web page at http://www.microchip.com. For more information on the RF transmitter test reports, contact Microchip Technology sales office.

Information on the New Zealand short range devices license can be found in the following web links:

http://www.rsm.govt.nz/cms/licensees/types-oflicence/general-user-licences/short-range-devices

and

http://www.rsm.govt.nz/cms/policy-and-planning/spectrum-policy-overview/legislation/gazette-notices/product-compliance

To meet overall New Zealand final product compliance, the developer must construct a compliance folder containing all relevant compliance test reports e.g. RF, EMC, electrical safety and DoC (Declaration of Conformity) etc. It is the responsibility of the developer to know what is required in the compliance folder for New Zealand Radio communications. For more information on New Zealand compliance, refer to the web site http://www.rsm.govt.nz/.

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4.5.1 EXTERNAL ANTENNA REQUIREMENTS

The compliance testing listed in Table 4-1 was performed using the antenna types listed in Table 3-1.

4.6 Japan

The MRF24WN0MA/MB module has received type certification and is labeled with its own technical conformity mark and certification number as required to conform to the technical standards regulated by the Ministry of Internal Affairs and Communications (MIC) of Japan pursuant to the Radio Act of Japan.

Integration of this module into a final product does not require additional radio certification provided installation instructions are followed and no modifications of the module are allowed. Additional testing may be required:

- If the host product is subject to electrical appliance safety (for example, powered from an AC mains), the host product may require Product Safety Electrical Appliance and Material (PSE) testing. The integrator should contact their conformance laboratory to determine if this testing is required.
- There is an voluntary Electromagnetic Compatibility (EMC) test for the host product administered by VCCI: http://www.vcci.jp/vcci_e/index.html

4.6.1 LABELING AND USER INFORMATION REQUIREMENTS

The label on the final product which contains the MRF24WN0MA/MB module must follow Japan marking requirements. The integrator of the module should refer to the labeling requirements for Japan available at the Ministry of Internal Affairs and Communications (MIC) website.

The MRF24WN0MA/MB module is labeled with its own technical conformity mark and certification number. The final product in which this module is being used must have a label referring to the type certified module inside:

Contains transmitter module with certificate number:

Pending

4.6.2 EXTERNAL ANTENNA REQUIREMENTS

The compliance testing was performed using the antenna types listed in Table 3-1.

4.6.3 4.6.2 HELPFUL WEB SITES

Ministry of Internal Affairs and Communications (MIC): http://www.tele.soumu.go.jp/e/index.htm

Association of Radio Industries and Businesses (ARIB): http://www.arib.or.jp/english/

4.7 Korea

The MRF24WN0MA/MB module has received certification of conformity in accordance with the Radio Waves Act. Integration of this module into a final product does not require additional radio certification provided installation instructions are followed and no modifications of the module are allowed.

4.7.1 LABELING AND USER INFORMATION REQUIREMENTS

The label on the final product which contains the MRF24WN0MA/MB module must follow KC marking requirements. The integrator of the module should refer to the labeling requirements for Korea available on the Korea Communications Commission (KCC) website.

The MRF24WN0MA/MB module is labeled with its own KC mark. The final product requires the KC mark and certificate number of the module:

Pending

4.7.2 EXTERNAL ANTENNA REQUIREMENTS

The Korea compliance testing was performed using the antenna types listed in Table 3-1.

4.7.3 HELPFUL WEB SITES

Korea Communications Commission (KCC): http://www.kcc.go.kr

National Radio Research Agency (RRA): http://rra.go.kr

4.8 Taiwan

The MRF24WN0MA/MB module has received compliance approval in accordance with the Telecommunications Act. Customers seeking to use the compliance approval in their product should contact Microchip Technology sales or distribution partners to obtain a Letter of Authority.

Integration of this module into a final product does not require additional radio certification provided installation instructions are followed and no modifications of the module are allowed.

4.8.1 LABELING AND USER INFORMATION REQUIREMENTS

The MRF24WN0MA/MB module is labeled with its own NCC mark and certificate number as below:

The user's manual should contain below warning (for RF device) in traditional Chinese:

注意！
依據 低功率電波輻射性電機管理辦法
第十二條 經型式認證合格之低功率射頻電機，非經許可，
公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計
之特性及功能。
第十四條 低功率射頻電機之使用不得影響飛航安全及干擾合法通信；
經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。
前項合法通信，指依電信規定作業之無線電信。
低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性
電機設備之干擾。

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5.0 ELECTRICAL CHARACTERISTICS

Table 5-1, Table 5-2, Table 5-3 and Table 5-4 provide the absolute maximum ratings, recommended operating conditions, current consumption and the DC characteristics for digital IO pins of the module.

TABLE 5-1: ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Description	Max Rating	Units
VDD	Voltage on VDD with respect to GND	-0.3 to 4.0	V
V_{DI} Min.	Minimum digital input voltage	-0.3	V
V_{DO} Max.	Maximum digital input voltage	VDD+0.3	V
RF_{IN}	Maximum RF input (referenced to 50 ohms)	+10	dBm

Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure above maximum rating conditions for extended periods may affect device reliability.

TABLE 5-2: RECOMMENDED OPERATING CONDITIONS

Symbol	Description	Min.	Typ.	Max.	Units
VDD	Supply voltage	3.15	3.3	3.45	V
TAMB	Ambient temperature under bias	-40	--	85	°C

TABLE 5-3: CURRENT CONSUMPTION(1) (NOMINAL CONDITIONS: 25°C, VDD = 3.3V)

Parameters	Min	Typ.	Max	Units	Conditions(2)
IDD, Hibernate	—	10	—	µA	—
IDD, Receive	—	61	—	mA	11 Mbps
	—	64	—		54 Mbps
	—	62	—		HT20 MCS0
	—	64	—		HT20 MCS7
	—	72	—		HT40 MCS0
	—	73	—		HT40 MCS7
IDD, Transmit	—	248	—	mA	1 Mbps
	—	246	—		6 Mbps
	—	242	—		11 Mbps
	—	211	—		54 Mbps
	—	263	—		HT20 MCS0
	—	217	—		HT20 MCS7
	—	222	—		HT40 MCS0
	—	196	—		HT40 MCS7

Note 1: Current Consumption values represent Typical Peak currents. Wi-Fi applications typically operate at less than 85% TX duty cycle. TX current is dependent on such criteria as transmit power setting, transmit data rate, and bandwidth used. RX current is affected by connection distance.

2: Transmit current consumption at power output levels listed in Table 5-6.

TABLE 5-4: DC CHARACTERISTICS FOR DIGITAL IO PINS

DC CHARACTERISTICS		Operating Conditions(1)			
Symbol	Parameter	Min.	Typ.	Max.	Units
VIH	High-Level Input Voltage	1.8	—	3.6	V
VIL	Low-Level Input Voltage	-0.3	—	0.3	V

TABLE 5-4: DC CHARACTERISTICS FOR DIGITAL IO PINS (CONTINUED)

DC CHARACTERISTICS		Operating Conditions[1]			
Symbol	**Parameter**	**Min.**	**Typ.**	**Max.**	**Units**
VOH	High-Level Output Voltage	2.2	—	3.3	V
VOL	Low-Level Output Voltage	0	—	0.4	V
IIH	High-Level Input Current	—	—	0.1	µA
IIL	Low-Level Input Current	—	—	0.1	µA
IOH	High-Level Output	—	—	20	mA
IOL	Low-Level Output Current	—	—	20	mA
CIN	Input Capacitance	—	3		pF

Note: Operating temperature: 25°C; Operating voltage: VDD = 3.3V

Table 5-5, Table 5-6 and Table 5-7 show the frequency characteristics of the module.

TABLE 5-5: RADIO RECEIVER CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Typ[1]	Max	Unit
fRX	RX input frequency range	—	2.412	—	2.472	GHz
sRF	Sensitivity					
	CCK	1 Mbps	—	-95.7	—	dBm
		11 Mbps	—	-87.7	—	
	OFDM	6 Mbps	—	-92.7	—	
		54 Mbps	—	-75.7	—	
	HT20	MCS0	—	-92.7	—	
		MCS7	—	-72.7	—	
	HT40	MCS0	—	-90.7	—	
		MCS7	—	-69.7	—	

Note 1: Performance measured at J1.

TABLE 5-6: RADIO TRANSMITTER CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
fRX	TX output frequency range	—	2.412	—	2.472	GHz
pOUT	Output power[1]					
	802.11b mask compliant	1 Mbps	—	20.7	—	dBm
	802.11g mask compliant	6 Mbps	—	20.7	—	
	802.11g EVM compliant	54 Mbps	—	18.8	—	
	802.11n HT20 mask compliant	MCS0	—	20.7	—	
	802.11n HT40 mask compliant	MCS0	—	18.5	—	
	802.11n HT20 EVM compliant	MCS7	—	18.0	—	
	802.11n HT40 EVM compliant	MCS7	—	18.4	—	
aPC	Accuracy of power control	—	—	+/-1.5	—	dB

Note 1: Performance measured at J1.

TABLE 5-7: SYNTHESIZER CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
fC	Center channel frequency	Center frequency at 5 MHz spacing	2.412	—	2.472	GHz
fREF	Reference oscillator frequency	+/-20 ppm	—	40	—	MHz
fSTEP	Frequency step size (at RF)	—	—	5	—	MHz

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APPENDIX A: REVISION HISTORY

Revision A (August 2015)

This is the initial released version of the document.

NOTES:

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NOTES:

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PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	I	RM	XXX
Device	Temperature Range	Package	Firmware Revision Number

Device:	MRF24WN0MA: MRF24WN0MB:	Integral Antenna External Antenna Connection
Temperature Range:	I =	-40°C to +85°C (Industrial)
Package:	RM =	Radio Module

Examples:

MRF24WN0MA-I/RM

NOTES:

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